

Research Article

Effect of Using Textiles Containing Copper and Zinc in Dogs with Superficial Pyoderma

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Abstract

The use of metallic particles is one of the promising therapies to avoid the use of antimicrobials and is a new therapeutic alternative for the control of cutaneous infections in dogs. Copper and zinc, which have been shown to be effective against various pathogenic agents, show antimicrobial activity against several strains of fungi and bacteria, inhibiting the synthesis of proteins, altering the cell membrane, inducing oxidative damage and the lysis of nucleic acids, and eliminating the microbes in contact with the particles. The aim was to evaluate the effect of using textiles containing particles of copper and zinc in dogs with superficial pyoderma. Were included 15 dogs of different breeds and both sexes, with an average age of 3.23 ± 1.17 years, which did not receive any treatment, systemic or topical, before or during the evaluation? Each dog with a previous diagnosis of superficial pyoderma was placed in a body with copper and zinc for 15 days, according to the manufacturer's instructions. No topical or systemic treatment was administered. Cytologies were performed on days 1, 3, 5, 10 and 15 to evaluate the presence of polymorphonuclear leukocytes, bacteria, and yeast. The polymorphonuclear and extracellular cocci showed a statistically significant constant decrease between days 1, 3, 5, 10 and 15, the number of yeast gradually decreased during the study. The use of textiles containing copper and zinc particles resulted in a decrease in polymorphonuclear cells, cocci, and yeast present in dogs with superficial pyoderma.

Keywords: Copper; Zinc; Textile; Pyoderma; Cytology

Introduction

Metal particles have stood out among the most promising molecules with antibacterial properties due to their biocidal effects at low concentrations [1], such is the case for copper and zinc, which have been shown to be effective against various pathogenic agents, including gram-positive and gram-negative bacteria and yeast [2,3], by inhibiting protein synthesis, inhibiting the synthesis of the cell wall of the microorganism, inhibiting cell membrane function, inducing oxidative lipid damage, and inhibiting the synthesis of nucleic acids due to their binding to components involved in the processes of DNA and RNA synthesis, thus compromising the multiplication and survival of microorganisms and generating contact elimination [4,5]. Canine pyoderma is one of the most common diseases diagnosed in the dermatological area of dogs [6]. It is a common complication of several skin disorders, and contributes to the appearance of pruritus and severe inflammatory changes and generates secondary infections [7]. It has been reported that *Staphylococcus pseudintermedius*, *S. aureus*, and *S. schleiferi*, are the most predominant pathogens in dogs

pyoderma [8], followed by *Malassezia pachydermatis* [9]. Surface pyoderma therapy usually requires long-term treatment and is often complicated due to increased resistance to antimicrobials [10]. There is extensive research on the excessive application of antimicrobials, which dramatically increases the selective pressure on bacteria, which have adapted to avoid being eliminated by these antimicrobials [11]. With the emergence of strains resistant to most systemic antimicrobials for veterinary use, interest has been generated in the use of topical therapy in canine pyoderma [12] and how to use antiseptics such as chlorhexidine [13]. The objective of the present investigation was to evaluate the effect of using textiles containing copper and zinc in dogs with superficial pyoderma.

Methods

Animals

The research was conducted at the Veterinary Hospital, Animal Space, from February to April 2019. The study included 15 dogs, nine males and six females, with the following distribution of breeds: four mixed-breed, three Standard Schnauzer, two Bulldog, two American Pitbull, one Xoloitzcuintli, one French Bulldog, one Poodle, and one Boxer, with previous signed informed consent by the owners. The inclusion criteria were: dogs with superficial pyoderma; no pharmacological, systemic, or topical treatment for pyoderma received, the owner agreed to sign the informed consent; and a known history of treatment and evaluations. The average age was 3.23 ± 1.17 years. During the evaluation period, the dogs did not receive any topical or systemic treatment other than the placement of the textile containing copper and zinc. At the end of the sampling, all the dogs were treated in a specific way according to the disease they suffered from.

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Treatment

A copper body (Copper Vet®) was placed on each dog according to the manufacturer's instructions, so that the areas to be evaluated were in direct contact with the textile. The "bodies" contained 68% cotton, 33% polyester yarn with copper and zinc particles equivalent to 2.64% (90% copper and 10% zinc), and 4% elastane. Cytological evaluations were performed according to Udenberg et al. [14] for assessment of the presence of Polymorphonuclear Leukocytes (PMN), Intracellular Cocci (IC), Extracellular Cocci (EC), and yeast, on days 1, 3, 5, 10, and 15. Five cytological samples were taken from each dog. Depending on the area that was injured, the evaluations were carried out every day in the same area, taking three samples per zone. The samples were taken by imprint or swab according to the anatomical region to be evaluated.

Statistical analysis

To determine the normality of the data, the Shapiro Wilk test was used. Since the data did not present a normal distribution, the nonparametric Wilcoxon rank test (paired) was used to determine differences between the days of patient evaluation. For this analysis, an alpha of 0.05 was considered significant.

Results

Table 1 shows the results of the PMN evaluations that showed a statistically significant difference between day 1 and day 3 ($p=0.0002$), day 3 and day 5 ($p=0.0001$), day 5 and day 10 ($p=0.0001$), and between day 10 and 15 ($p=0.0031$), showing a constant decrease throughout the experiment. The evaluation of the presence of IC did not reveal significant differences for the intervals between the measurements, and only presented a minimum tendency to decrease from day 1 to 5 and subsequently remained unchanged. In contrast, the presence of EC significantly decreased between day 1 and 3 ($p=0.0017$), day 3 and 5 ($p=0.0001$), 5 and 10 ($p=0.0001$), and 10 and 15 ($p=0.0001$). Regarding the evaluation of the presence of yeast, from day 1 to 3 there was a slight increase; however, this difference was not statistically significant. From day 3 to 5 a significant decrease in the presence of yeast was observed ($p=0.0005$), from day 5 to 10 again there was no statistical difference even though there was a numerical decrease, and finally from day 10 to 15, there was significant difference ($p=0.0039$), indicating a sustained decrease throughout the study.

Discussion

Skin infections in dogs occur frequently and often present therapeutic challenges for professionals [15]. Currently, the appearance of multiresistant microorganisms with few or no options for systemic therapy with antibiotics [16] has provided a new opportunity for the use of topical treatments, such as copper and zinc particles, which can be effective and economical antimicrobials, acting through multiple pathways, thus limiting the opportunities for

bacteria to gain resistance [17]. The results of this research show that the use of clothing with fibres containing copper and zinc reduces the presence of bacteria, yeast, and polymorphonuclear leukocytes in areas that are in contact with these particles. Similar results were reported by Borwok et al. [18] who manufactured non-stick dressings composed of a cloth impregnated with 2.65% copper particles, which were applied to wounds inflicted on genetically modified diabetic mice. The effectiveness of the antimicrobial dressing was 99.9%. It has been reported that dressings containing compounds such as copper are a promising biomaterial for the healing of wounds infected with *staphylococci* [19], one of the most recurrent pathogens in this type of dermatological problem, since copper shows a great potential to control gram-positive and negative bacteria that are multi-resistant to antibiotics [4], similar to those found in dog pyoderma. In a study conducted by Butler [20], who evaluated the use of bed clothing impregnated with copper oxide as a biocidal measure in hospitals, a significant reduction in the main pathogenic microorganisms associated with nosocomial diseases was observed. The results were similar to those found in the present investigation, where dogs with clothes containing copper and zinc fibres showed a reduction in the abundance of bacteria and yeast from day 5 of evaluation. Jain and Tesema [5] report that textiles made with zinc pyrithione reduced the growth of *Staphylococcus aureus* by 70.95% and *Escherichia coli* by 99.99%, and had a durable antimicrobial effect through several mechanisms, including interruption of the folic acid pathway, which is essential for bacteria to produce important precursors for DNA synthesis. Rajendran et al. [21] demonstrated that cloth treated with zinc oxide nanoparticles showed a higher antibacterial activity than untreated cloth, and the antibacterial activity was higher against *S. aureus*, with a reduction percentage of 94.16%, than against *E. coli*, with a reduction percentage of 86.5%. This can be attributed to the reactive oxygen species generated by the zinc oxide particles, which could be a mechanism to inhibit the growth of bacteria, although there is no direct evidence for the results of this work. In an *in vitro* study, the bactericidal efficacy of copper textiles was reported after 15 minutes of being in contact with nosocomial pathogens [22], corroborating the results reported in the present study. Marcus [23] obtained positive results with the use of bed clothes and towels containing copper oxide to reduce nosocomial diseases in chronic patients with ventilator dependence.

It has been reported that zinc salts have a residual antimicrobial effect when they are deposited on textiles such as nylon, polyester, and cotton. It is effective against several types of gram-positive bacteria, gram-negative bacteria, and fungi [24]. This might be due to the fact that zinc particles are capable of producing Reactive Oxygen Species (ROS) that prevent the development of biofilms of *E. coli* and *S. aureus*, and it has been found that in suitable concentrations, zinc particles have antibacterial activity without affecting normal cells [25], which could favor the decrease in abundance of bacteria and yeast in the dogs evaluated in this research, and also agrees with Irene and colleagues [22], who claim that the use of antimicrobial textiles can play an important role in reducing pathogens. The use of copper and zinc in garments for dogs decreased the number of bacteria and yeast present, therefore, such garments are useful for the topical management of superficial pyoderma. However, this is not recommended as a single therapy, but instead as part of the multimodal handling of superficial pyoderma.

Conflict of Interest

All authors voluntarily published this article and have no personal

Table 1: Comparison of the abundance of PMN, IC, EC, and yeast between the days of treatment.

Days	1-3	3-5	5-10	10-15
PMN	9.54-7.48	7.48-3.33	3.33-1.69	1.69-0.56
P-value	0.0002	0.0001	0.0001	0.0031
IC	0.37-0.05	0.05-0.02	0.02-0.02	0.02-0.02
P-value	0.06	0.5	1	1
EC	14.97-10.17	10.17-4.86	4.86-3.21	3.21-0.90
P-value	0.0017	0.0001	0.0001	0.0001
Yeast	2.50-2.57	2.57-1.42	1.42-0.92	0.92-0.36
P-value	0.99	0.0005	0.064	0.0039

Test of Wilcoxon ranges, 0.05 alpha

interest in this study other than publishing the scientific findings that they have been involved in via planning, initiating, monitoring, and conducting the investigations and analysing the results.

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